# Environmental impact assessment of sustainable consumption and production patterns at macro-scale: state of the art, limitations and possible ways forward


## Abstract

Sustainable consumption and production (SCP) is intended by many to be a holistic approach aiming towards minimization of negative environmental impacts from the production-consumption systems in society. The way environmental impacts of SCP patterns are assessed at macro-scale has many different operational declinations which build on different theoretical backgrounds, accounting frameworks, as well as methodologies and underlying data. We performed a literature review in order to systematize the existing indicators, considering bottom up, top-down and hybrid approaches. The mainstream methodologies are hierarchically different and may entails: mere pressure indicators, composite indicators, and other more complex multi criteria indicators aiming at assessing environmental impacts (e.g. life cycle based indicators). Underlying data to quantify the emissions and resources associated to societies' CP can be broadly grouped in three classes: environmentally extended input-output tables, process-based life cycle assessment and hybrid methods based on the two previous. In this paper, an overview of these methodologies is provided along with the discussion of their advantages and drawbacks for SCP assessment.


## Introduction

According to the definition of sustainable consumption and production (SCP) developed in the Oslo Declaration and formalized by OECD (1997), SCP is "*a holistic approach to minimizing negative environmental impacts from the production-consumption systems in society".* Moreover, according to EEA (2013), "*SCP aims to reduce emissions, increase efficiencies and prevent unnecessary wastage of resources within society through the stages of material extraction, investment, production, distribution, consumption to waste management. In addition to these environmental and economic goals, the social component is concerned with equity within and between generations, improved quality of life, consumer protection and corporate social responsibility (CSR)."* The way environmental impacts of SCP patterns are assessed at macro-scale has many different operational declinations which build on different theoretical backgrounds, accounting frameworks, as well as methodologies and underlying data. The objective of this paper is to provide an overview of mainstream modelling techniques and assessment frameworks found in literature and presenting then the key advantages and drawbacks of each approach. Although acknowledging the utmost importance of social and economic aspects, the current analysis is limited to those frameworks aimed at assessing with the environmental impacts SCP patterns.

## Methods

A review of key studies on the topic of environmental impacts associated with SCP patterns, mostly referring to the EU was carried out in order to collect the relevant background information. The studies have been then grouped according to the modelling framework which they are built upon. A set of criteria against which to assess the main methodological framework has been developed. The criteria covered the following aspects: completeness of the methodology (e.g. in terms of life cycle phases evaluated, environmental impacts), resolution (geographical, temporal), representativeness (production, consumption), communicability of the resulted indicators and policy relevance.

**Results**

On the basis of the literature review three cluster of methodologies has been identified: bottom up, top-down and hybrid approaches.

The environmental accounting frameworks which are most commonly applied to assess impacts associated with SCP patterns at macro-scale belong to the following groups: pressure indicators, footprints (Galli et al., 2102; 2013), LCA-based footprints (Ridoutt and Pfister, 2013).

Pressures indicators are variables which do not translate into potential impacts to human health, ecosystems or resource depletion (e.g. energy consumption, land consumption, etc.) but, instead, able to communicate figures on resource inputs which can be understood by the general public.

Footprint and LCA-based footprints, aims at combining pressure data (representing the inventory) into impact indicators (resulting from the combination of the inventory with an impact assessment methodology)

Inventories built following bottom-up approaches refer to the use of life cycle inventory data (LCI) or other data sources for specific representative products which are then up-scaled to overall final consumption figures through varying up-scaling techniques “from details to aggregate”. Top-down methodologies generally combine Environmentally Extended Input-Output tables (EE-IOTs) (either multi-regional or single-region methods) and households’ expenditure statistics in order to assess environmental burdens of consumption patterns “aggregate to details”. Hybrid approaches present mixed features of both bottom-up and top-down methodologies.

Each of the three foundations has advantages and drawbacks at the same time. Bottom-up methods present a high coverage of emissions and resources input for specific products and processes; however the selection of a representative product among many for representing a homogeneous group of traded or consumed goods is extremely sensitive. The same is true for the selection of the up-scaling strategy for estimating impacts at the level of the product group. Oppositely, EEIOTs are tools which allows to allocating total emissions and resources input to final consumption by keeping the totals constant. The key drawbacks of these methods are related to the limited number of pollutants and resources they do account for, as well as to the level of geographical and sectorial differentiation. Similarly, the lack of available physical IOTs implies the use of economic IOTs leading to potential distortions when assessing the environmental burden associated with final expenditure. Hybrid methods are, instead, aimed at compensating the limitations of the two approaches by combining the IOT structure and the precision of process-based life cycle assessment, in order to improve the coverage of pollutants and resource input.

**Conclusions**

Three main groups of modelling approaches are available for developing inventories of emissions and resource inputs associated with SCP patterns; their advantages and disadvantages had been presented and discussed within this work. Similarly, three mainstream methodologies were found to be commonly applied in assessing environmental pressures and impacts, their strengths and limitations as well as compatibility with the modelling approaches of SCP had been discussed as well. Overall, each of the combinations of methods shows advantages and crucial drawbacks. The fitness of these methods to the purpose of a specific research question must be however always evaluated in consideration of the final purposes and uses of the assessment.

**References**


- European Environment Agency, (2013). Environmental pressures from European consumption and production – A study in integrated environmental and economic analysis. EEA Technical Report No 2/2013, ISSN 1725-2237. European Environment Agency, Copenhagen.
- Galli A,Wiedmann TO, Ercin AE, Knoblauch D, Ewing BR, Giljum S. 2012 Integrating ecological, carbon, and water footprint into a footprint family of indicators: definition and role in tracking human pressure on the planet. Ecol Indic 2012; 16:100–12.
- Galli A., Weinzettel J., Cranston G., Ercin E. 2013. A Footprint Family extended MRIO model to support Europe's transition to a One Planet Economy. Science of the Total Environment 461-462 (2013) 813-818
- OECD, 1997 Sustainable Consumption and Production. Organization for Cooperation and Development, Paris, Paris.
- Ridoutt and Pfister, 2013. Towards an Integrated Family of Footprint Indicators. Volume 17, Number 3 Journal of industrial Ecology, DOI: 10.1111/jiec.12026